MINING METHODS AT THE BRUCITE DEPOSIT BASIC REFRACTORIES, INC. GABBS, NYE COUNTY, NEV.

BY GEORGE H. HOLMES, JR.

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by

George H. Holmes, Jr.1/

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INTRODUCTION

This paper is one of a series on mining methods and practices being prepared by the Mining Division of the Bureau of Mines. It describes briefly operations and mining methods at the Basic Refractories, Inc., brucite deposit, the only commercial deposit of brucite in production in the United States.

The mine and crushing plant are in secs. 26 and 35, T. 12 N., R. 36 E., M. D. B. & M., northwestern Nye County, Nev., 1 mile east of Gabbs and about 33 miles northeast of Luning, a town on the Mina branch of the Southern Pacific Railroad and U. S. Highway 95. (Figs. 1 and 2).

ACKNOWLEDGMENTS

Acknowledgment is made to the Basic Refractories, Inc., 845 Hanna Building, Cleveland, Ohio, for permission to publish this paper and for the valuable help of their staff at Gabbs in preparation of the manuscript and maps. Special acknowledgment is due H. C. Lee, vice-president and technical director, and N. E. Hanson, manager of operations, for their critical review of this circular.

HISTORY AND PRODUCTION

Brucite and magnesite deposits in the Mammoth Mining District were discovered and claims were located by H. E. Springer in 1927 and 1928. The property was sold to the United States Brucite Corp., 155 Sansome Street, San Francisco, Calif., in 1930, and this company prospected the deposits by diamond drilling. Through 1931, production was limited to small shipments to various laboratories for testing.

The claims and certain buildings owned by the United States Brucite Corp. (fig. 3) were leased in 1936 by Basic Ores, Inc., a subsidiary of Basic Refractories, Inc., for a period of 35 years. Systematic exploration and development of the deposits was started, and production continued until 1941, when the property was taken over by the parent company. Operations by Basic Refractories have been continuous since 1941.

On January 28, 1949, Basic Refractories, Inc., entered into an agreement with War Assets Administration whereby they purchased the adjoining Basic Magnesium, Inc., property. This area is designated Basic Refractories, Inc., on figure 3.

Brucite ore is shipped to the company's plant at Maple Grove, Ohio, and is used in the manufacture of fire brick and refractories for lining open-hearth steel furnaces.

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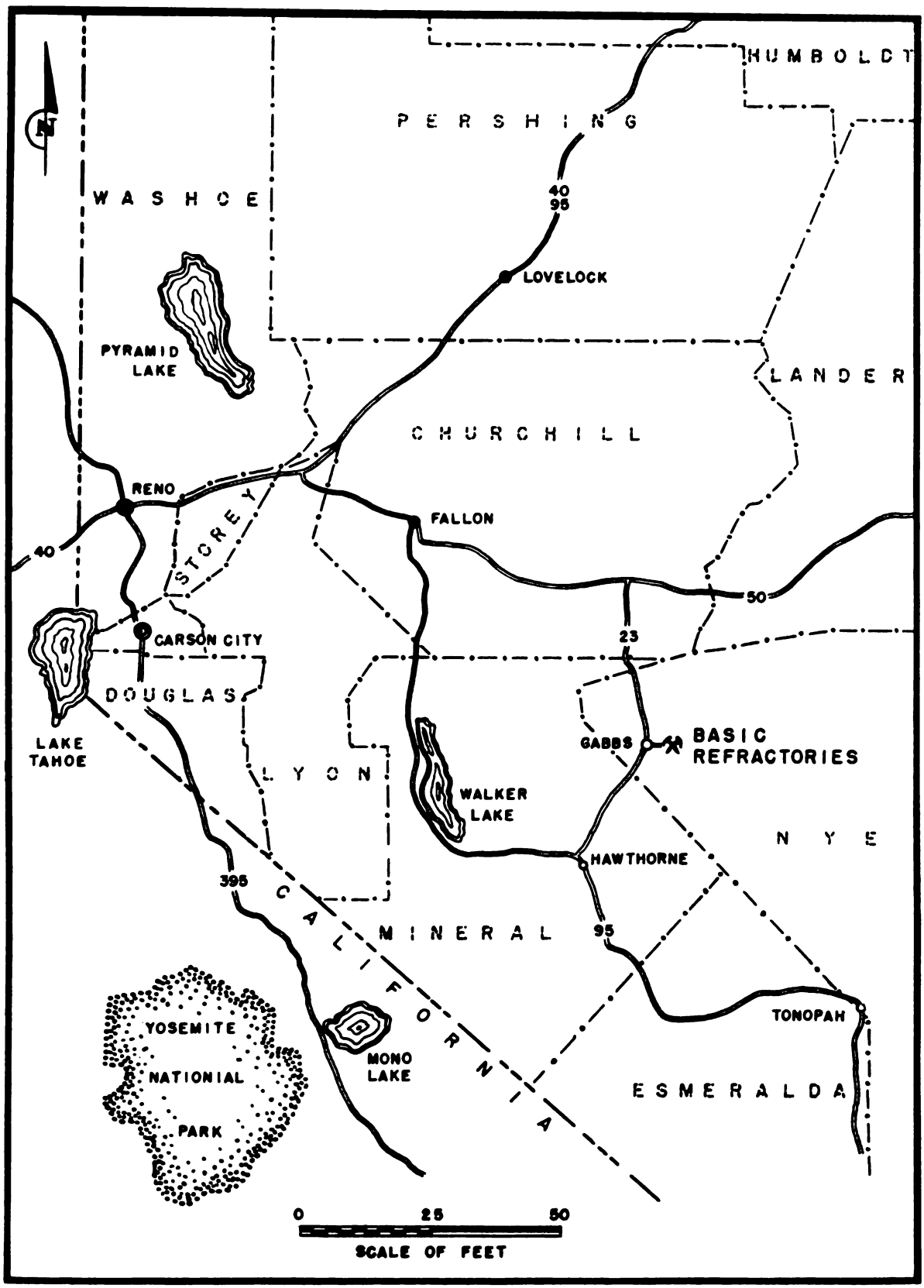

Figure 1. - Location map, Basic Refractories, Inc., Nye County, Nev.

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Figure 2. - View of Basic Refractories camp, Gabbs, Nye County, Nev., looking southwest.

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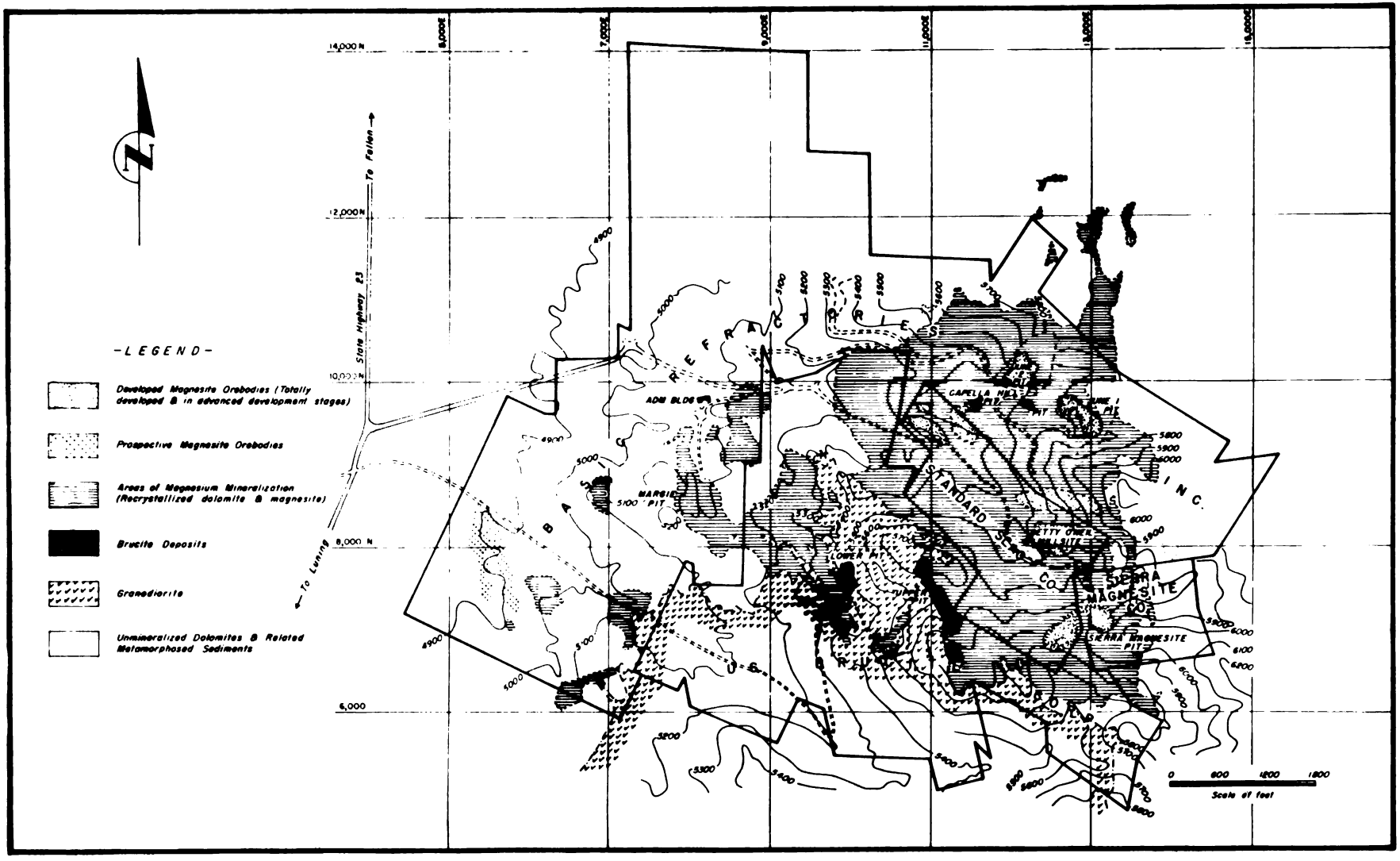

Figure 3. - Topographic, geologic, and property map.

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The production record from 1941 to 1948 is:

Year	Tons
1941.....	41,987
1942.....	39,782
1943.....	66,692
1944.....	48,217
1945.....	56,251
1946.....	41,717
1947.....	45,797
1948.....	41,780

Present daily production is 500 tons of ore, from which about 175 tons of refractory-grade brucite is sorted and shipped.

PHYSICAL FEATURES AND COMMUNICATIONS

The mine and camp are on the west slope of the Paradise Range in west-central Nevada. Relief of the area is fairly rugged, extending from an altitude of 5,200 feet at the camp to 5,800 feet at the upper pit.

The climate is semi-arid, with hot, dry summers and moderately cold winters. Light falls of snow have not seriously hampered production.

The camp comprises 27 buildings, consisting of an office, boarding house, 2 bunk houses, 9 cabins, 2 bathhouses, 4 residences, 3 garages, 2 storehouses, 2 generator houses, and a completely equipped assay office. Although transmission-line power is available at the former Basic Magnesium, Inc., plant a mile to the north, the company has found it more economical to use Diesel-generated power for its operations. Two Diesel generators supply power for the camp, and one unit furnishes power for the crushing plant, conveyor belts, and sample-preparation equipment.

Water is pumped from wells in Gabbs Valley to storage tanks at the Basic Magnesium plant and is hauled in a tank truck from these tanks to the camp and diamond drills.

Telephones are available at the mine office.

State Highway 23 passes about a mile to the west, connecting with U. S. Highway 50, 31 miles to the north, and U. S. Highway 95, 33 miles to the south.

Freight and express shipments are handled at Luning, a small town on the Mina branch of the Southern Pacific Railroad at the junction of Highways 23 and 95.

LABOR AND LIVING CONDITIONS

The property is in a remote area distant from large Nevada towns and other sources of labor supply. Exceptionally good living conditions have attracted more efficient labor, and present turnover is low.

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Employees live in company bunkhouses and cabins on the property or in the town of Gabbs. The townsite at Gabbs is owned by Reconstruction Finance Corporation and operated under a lease by Basic Refractories, Inc. Houses are available for family men. A store, postoffice, and schools are maintained at the townsite.

Present sequence of operations is one 6-day week followed by one 5-day week. Mining and diamond drilling are on a two-shift-a-day basis, and trucking, sorting, and crushing are done on the day shift. Thirteen to fourteen men are required in the pit to drill, blast, load, and truck the broken ore; six drillers and helpers comprise the diamond-drill crew; and 18 to 20 workers are needed for sorting, crushing, and miscellaneous duties.

Diamond drilling is on a semi-contract basis; the drillers are paid on a footage scale, and the company furnishes equipment and supplies.

GEOLOGY

The area in the vicinity of the brucite deposits embodies limestones and dolomites, which have been intruded by a stock of granodiorite. These formations have a general north-south strike and dip west at varying degrees. The upper and lower brucite deposits are within zones of contact metamorphism on the east and west sides of a tongue of granodiorite that projects into the sedimentary rocks. (Fig. 3). Both deposits are crossed by numerous narrow dikes up to 5 feet in width and contain masses of magnesite, intermixed magnesite and brucite, and sections of unaltered limestone and dolomite. Hydromagnesite also is present in varying amounts. According to Callaghan[2/], the deposits of brucite and magnesite are believed to be the products of the action of hypogene magnesian solutions upon pre-existing dolomites, probably as a consequence of the granodioritic intrusion but not necessarily related closely to its present form.

DEPOSITS

The lower brucite deposit is about 300 feet long, 60 to 80 feet wide, and 30 to 50 feet deep. It has a general strike of N. 19° W. and dips steeply to the west. No record of production from this deposit is available, but mining has been suspended, as the excessive number of dikes and inclusions of waste rock made for excessive dilution of the ore, which necessitated highly selective mining and consequent high costs.

The upper deposit along the east side of the granodiorite tongue is about 900 feet long, 300 feet wide, and has been mined to a depth of about 280 feet. Explorations indicates a possible additional mining depth of 150 feet. The deposit has a general strike of N. 19° W. and dips about 83° to the west. Figures 4 and 5 show the plan and sections of the pit. This deposit also is crossed by numerous small dikes, both acid and basic, and tongues of granodiorite. Mining has disclosed sections of magnesite, hydromagnesite, and dolomite. Selective mining and hand sorting are necessary to remove the waste inclusions from the broken ore and produce a product suitable for use in the manufacture of refractories.

2/ Callaghan, Eugene, Brucite Deposit, Paradise Range, Nevada: University of Nevada Bull.

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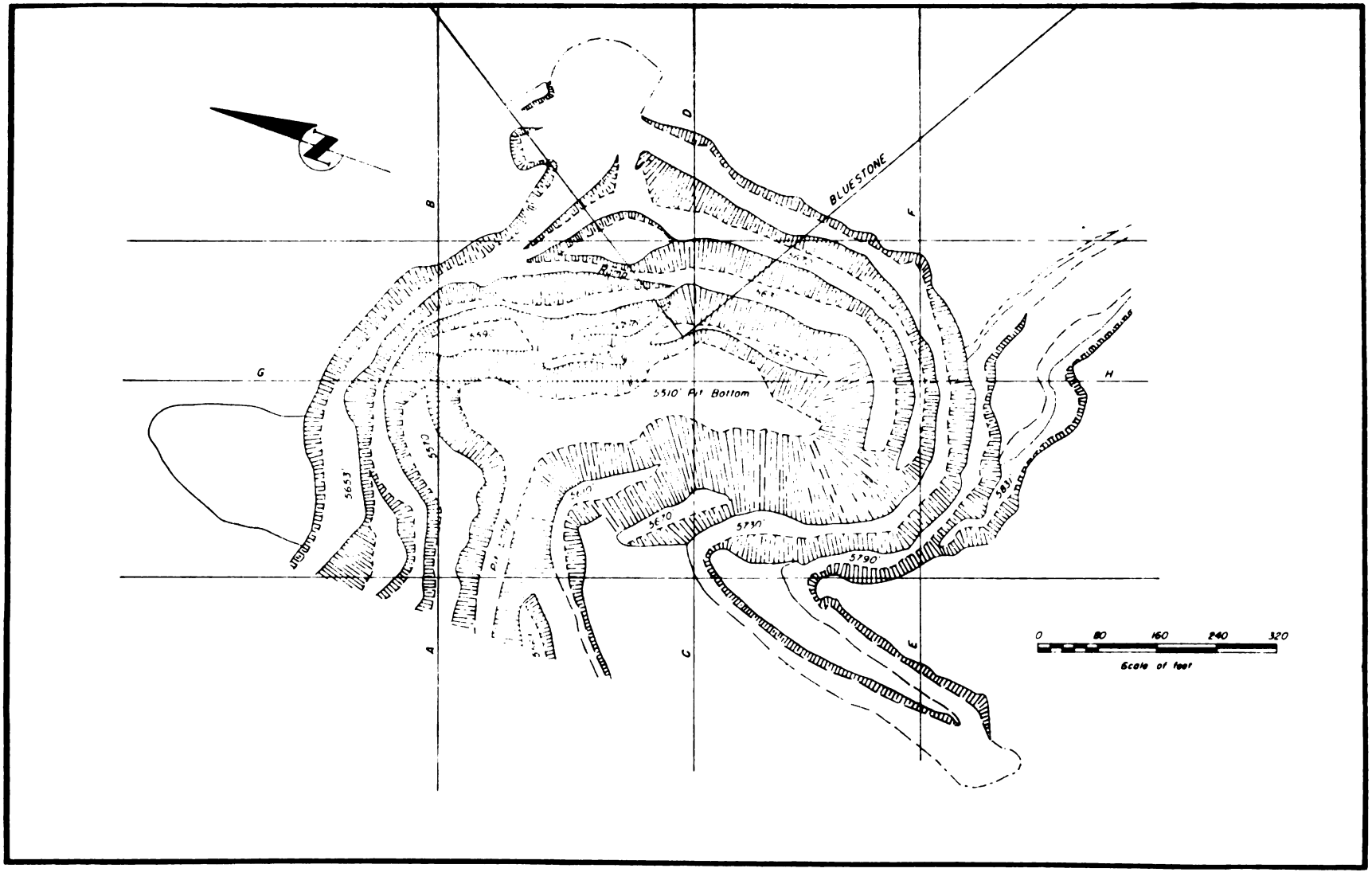

Figure 4. - Plan of upper brucite pit, Basic Refractories, Inc.

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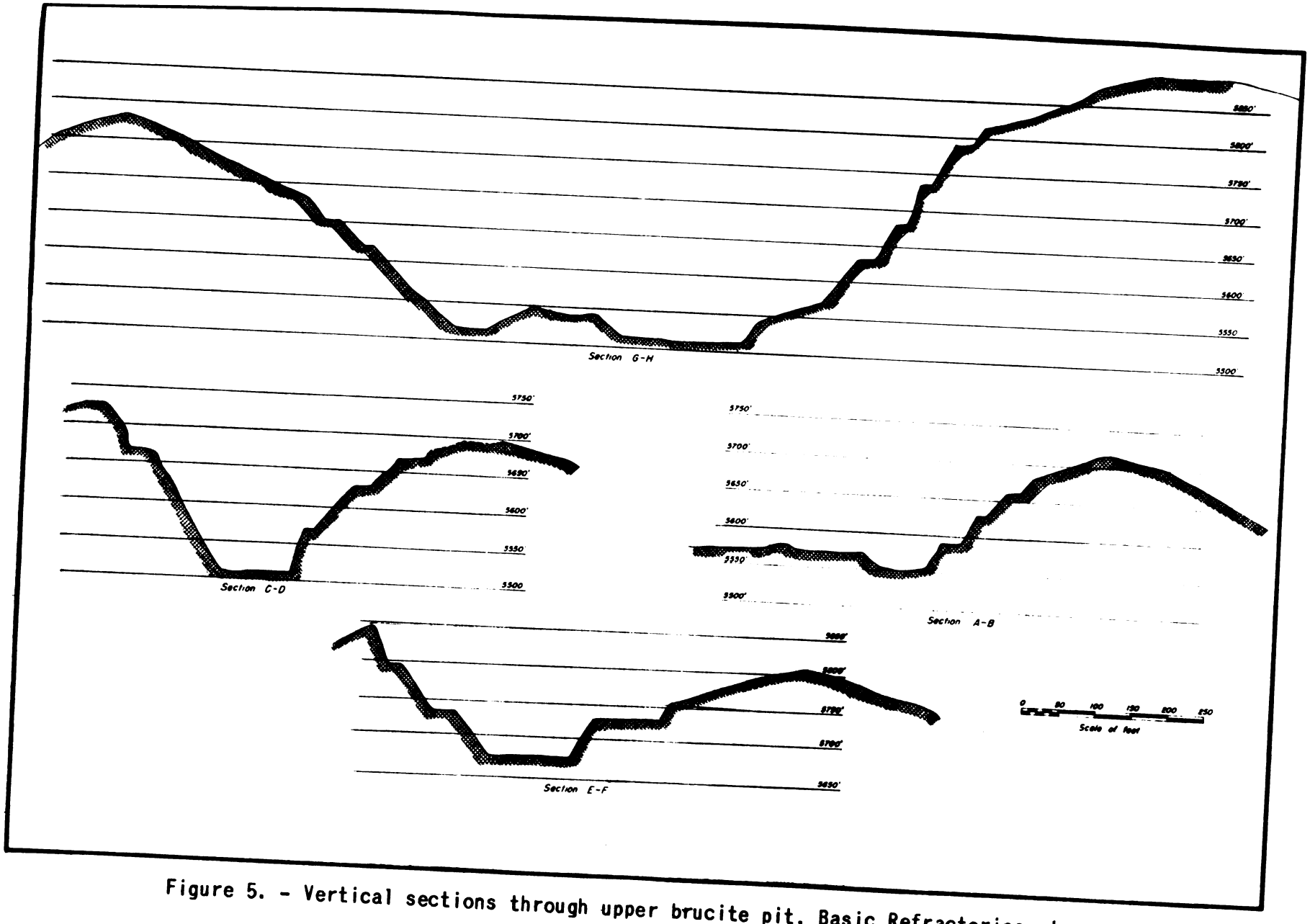

Figure 5. - Vertical sections through upper brucite pit, Basic Refractories, Inc.

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Company production records indicate that of the total tonnage mined through 1947, 22 percent has been shipping-grade ore, 23 percent sorting ore, and 55 percent waste from sorting, development work, and roads. The present ratio of high-grade brucite to the total tonnage produced is about 1:3.

ORE

Brucite has a soapy appearance and ranges in color from white through various shades of brown to black. Narrow stringers of high-grade crystalline blue-green brucite occur in the more massive brucite. Magnesite and hydromagnesite are intermixed with the brucite, and dolomite occurs in isolated masses.

The average analysis of 1947 shipments of refractory-grade brucite was:

	Percent
MgO	61.90
CaO	2.16
R_2O_3	1.80
Insoluble	4.37
Loss on ignition	29.77
	100.00

Limits of the various grades of brucite and magnesite are:

	Insoluble, percent	CaO, percent
Brucite:		
First-grade	4	5
Second-grade	10	10
Third-grade	15	15
Fourth-grade	20	20
Waste	+20	+20
Magnesite:		
First-grade	2.5	2.5
Second-grade	4.5	4.5
Third-grade	8.0	8.0
Waste	+8.0	+8.0

EXPLORATION

The upper and lower brucite deposits were systematically explored and delimited by diamond drilling. About 107 holes were drilled on a grid pattern to depths ranging from 25 to 533 feet. Almost all the holes were continued through the deposits and bottomed in the underlying granodiorite. Drilling was with the AX bit, and core recoveries ranged from 72 to 92 percent.

Prior to production of brucite from the upper deposit, 987,000 tons of overburden and waste rock were removed. This work was done under contract.

Exploration is being continued in a high-grade body of magnesite adjoining the upper brucite pit to the southeast. This deposit is underlain by dolomite and is being explored methodically by a series of core-drill holes

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ranging in depth from 300 to 400 feet. Two gasoline-driven diamond drills are now in operation on a two shift daily basis.

MINING METHODS

Mining

Ore is produced from the upper brucite deposit by open-pit mining. (Fig. 4 and 5). A series of benches 30 to 40 feet wide and with banks 40 to 60 feet high and sloping from 55 degrees to vertical have been opened around the pit. Entrance to the bottom of the pit is through a descending approach starting about 400 feet to the west. Benches are kept level and are reached by a series of ascending branch roads. Bottom of the pit was 280 feet below the top of the uppermost bench in November 1948.

The pit is being widened, and the north end will be lengthened to permit open-cut mining for an additional depth of 40 ft. The character of the ore body makes it impractical to continue pit operations below this level, and plans are to mine the brucite to the bottom of the deposit by underground methods.

Banks are mined by drilling parallel rows of down holes from the bench. The rows are 5 to 8 feet apart, depending on the character of the rock, and the holes are on 6-foot centers. Holes range from inclinations of 60 degrees to vertical and are drilled to depths of 24 to 25 feet. A row of toe holes is drilled on 6- to 8-foot centers along the base of the bank normal to the face to depths of 25 feet. A parallel series of breast holes is drilled 3 to 5 feet above the toe holes. Lifters are inclined 5 to 15 degrees downward, and the relievers are inclined 5 to 7 degrees upward. Forty to 75 holes comprise a round.

Benches are excavated to full width by driving them parallel to the bank. Parallel rows of toe and breast holes 4 to 5 feet apart vertically and spaced on 4 to 6 foot centers are drilled to average depths of 24 feet. Toe holes are inclined 10 degrees downward, and breast holes are inclined 10 degrees upward. Ten to twenty holes usually comprise a round.

Holes are drilled with wagon drills equipped with 4-inch blower-type drifters. Drilling is dry; the cuttings are removed by compressed air through the drill steel and blow pipes. Drill steel is 1-1/4-inch lugged hollow round in 6-foot changes, and detachable center-hole bits starting with a 3-inch size and with successive 1/8-inch changes are used. Compressed air is furnished by 215 c.f.m. and 350 c.f.m. portable compressors, and a bulldozer transports the wagon drills and compressors to and from the working faces. A miner and one helper comprise a wagon drill crew; two crews operate on day shift and one on night shift. A crew will drill 100 to 150 feet a shift.

Blasting

Holes are sprung once by using 7 to 8 cartridges of 40-percent gelatin dynamite and detonating electrically. Down holes are then loaded by gravity with a 40-percent free-running bag powder. Toe and breast holes are loaded

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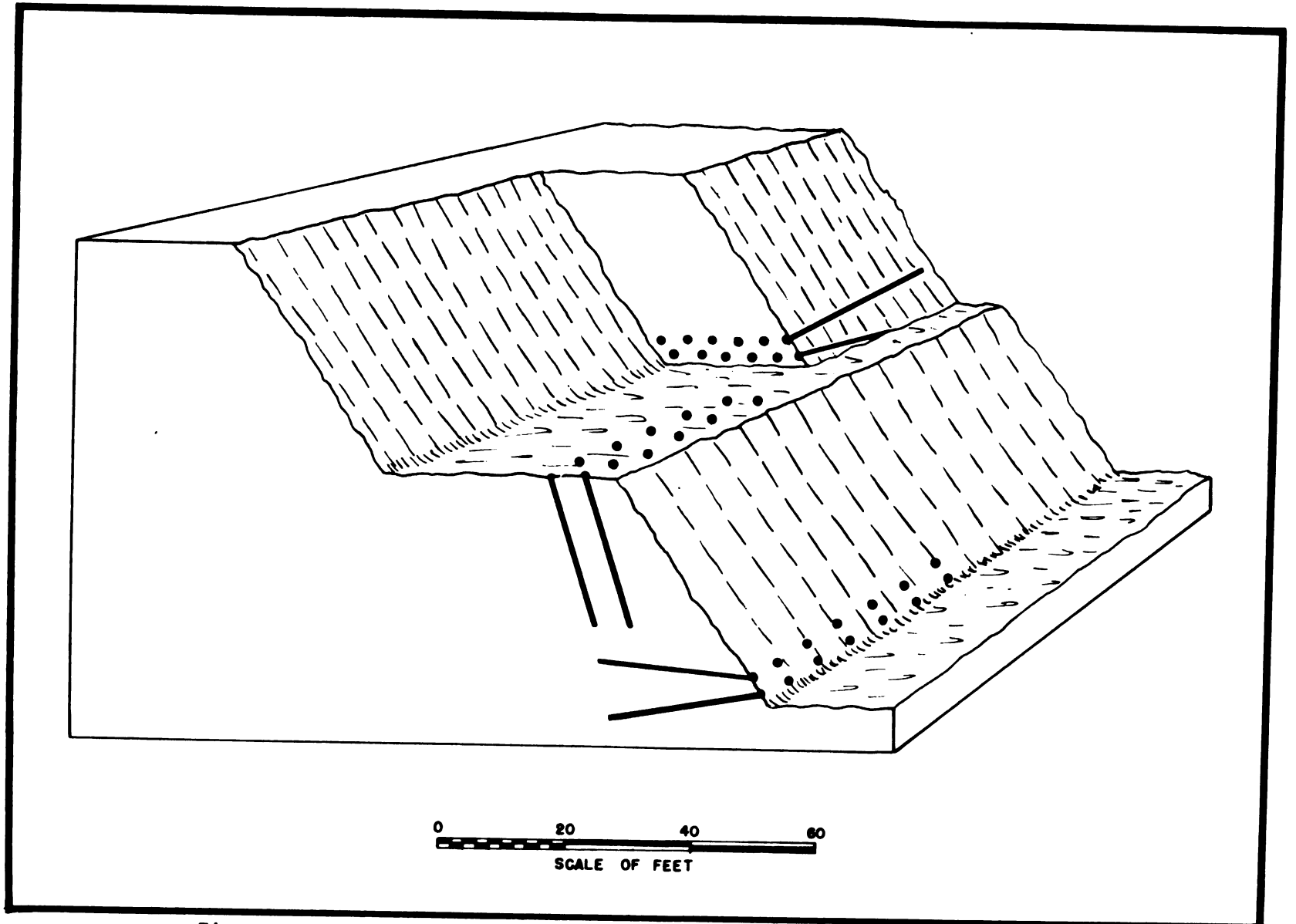

Figure 6. - Typical open pit and bench round, Basic Refractories, Inc.

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with bag powder by using a compressed-air loader. Thirty-five to 50 pounds of powder are used per hole, and detonation is by a No. 6 electric blasting cap in a cartridge of 60 percent gelatin dynamite placed in the bottom of the hole. Holes are tamped with 3 to 4 sand cartridges and are fired simultaneously.

Secondary blasting of large boulders is necessary, and this is accomplished by plastering 2-inch slices of 40-percent gelatin dynamite, cut from 4- by 24-inch sticks, on the boulders and detonating the charge with conventional fuse and cap.

The 1947 over-all consumption of powder was 97,150 pounds. An estimated 60 percent was used for primary blasting and 40 percent for secondary blasting of boulders and slabs too large to be handled by the shovel. In primary blasting, 3.3 tons were broken per pound of powder, and the cost of powder and electric blasting caps was $0.05 a ton. Cost of powder, caps, and fuse used in secondary blasting was $0.03 per ton produced.

Scaling

The face is cleared of loose rock and slabs, after a blast, by scaling. This work is done by the drill crew, that works down from the bench above the bank on ropes and bar down loose material.

Loading and Hauling

Loading and hauling ore are done on the day shift. The ore is loaded into three 7-ton-capacity dump trucks by a 1-1/2-cubic yard Diesel-driven power shovel, which adequately handles the ore broken in the pit and on the benches. A bulldozer cleans the pit and benches pushing loose material within reach of the shovel.

Dump trucks haul the ore to sorting benches, the crushing plant, stockpiles, or to a surge pile maintained in the lower brucite pit, dependent on the grade and type of ore. Stock piles are maintained of shipping ore, sorting-grade brucite, and magnesite. The haul from the pit to the crushing plant is 0.5 mile. Stock-piled ore is reloaded from the surge pile into a 3-ton-capacity dump truck by a 3/8-cubic yard Diesel-driven, power shovel and hauled to the crushing plant.

Sorting

Ore, which is intermined with dike material and waste rock, is dumped on sorting benches, where 8 to 10 laborers sort out the waste by hand. Larger pieces of rock are blasted to permit close grading. Sixty to 70 tons of high-grade brucite is produced daily by sorting. Sorted ore is loaded in 1-1/2-cubic yard buckets and hauled to the crushing plant by load luggers mounted on 1-1/2-ton truck chassis.

Equipment

The following equipment is used in mining and hauling:

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2 Wagon drills, 3-1/2-in. cyl. bore
1 Wagon drill, 4-in. cyl. bore
2 215 c.f.m., portable, gasoline-driven compressors (different makes)
1 315 c.f.m., portable, gasoline-driven compressor
1 1-1/2 cu. yd. Diesel-powered shovel
3 7-ton-capacity dump trucks
2 1-1/2 cu. yd. load luggers
1 Caterpillar tractor equipped with 7-foot angle dozer
1 Powder loader
1 3/8 cu. yd. Diesel-powered shovel
1 3-ton-capacity dump truck
1 2-kw. light plant
2 Diamond drills; capacity: 600 feet, A-rods
2 Pumps, 25 g.p.m., driven by gasoline engine

CRUSHING PLANT AND SAMPLE PREPARATION

Trucks back up an inclined ramp and dump the ore over a 3-inch grizzly (fig. 7), the undersize dropping to the ore belt conveyor and the oversize fed to a jaw crusher. The crushed ore is fed to the ore belt conveyor by an automatic feeder; the fines are passed to a crossbelt conveyor, dropped onto the waste conveyor belt, and carried to a waste bin.

The ore conveyor belt is used for further sorting. Two laborers pick out waste rock and drop it into waste bins.

Ore passes from the conveyor belt to a second belt conveyor, which carries it to a 164-ton-capacity, circular, steel storage bin, or it can be diverted to a third belt conveyor and transferred to a second 164-ton storage bin.

The Wells-Cargo Co., a trucking freight company from Reno, Nev., hauls the high-grade brucite in 28-ton-capacity dump trucks from the ore bins to rail cars at Luning. This 33-mile haul is done under contract.

The crusher is V-belt driven by a 125-h.p. Diesel engine, and the conveyor belts are motor driven. A 60-kw. Diesel generator supplies power for the motors, machine shop, and sample-preparation equipment.

A fully equipped machine shop situated adjacent to the crushing plant and a portable electric welder are used to maintain repairs.

The crushing laboratory prepares samples for assaying and is situated just west of the crushing plant. Samples are split, crushed in a gasoline-driven jaw crusher, further reduced in a secondary jaw crusher, and ground in disk crushers. Samples are then sacked and weighed and sent to the assay office. Diamond-drill cores are split; half are prepared for assaying and the other half are retained for logging and future reference.

The following equipment is used for crushing and sample preparation:

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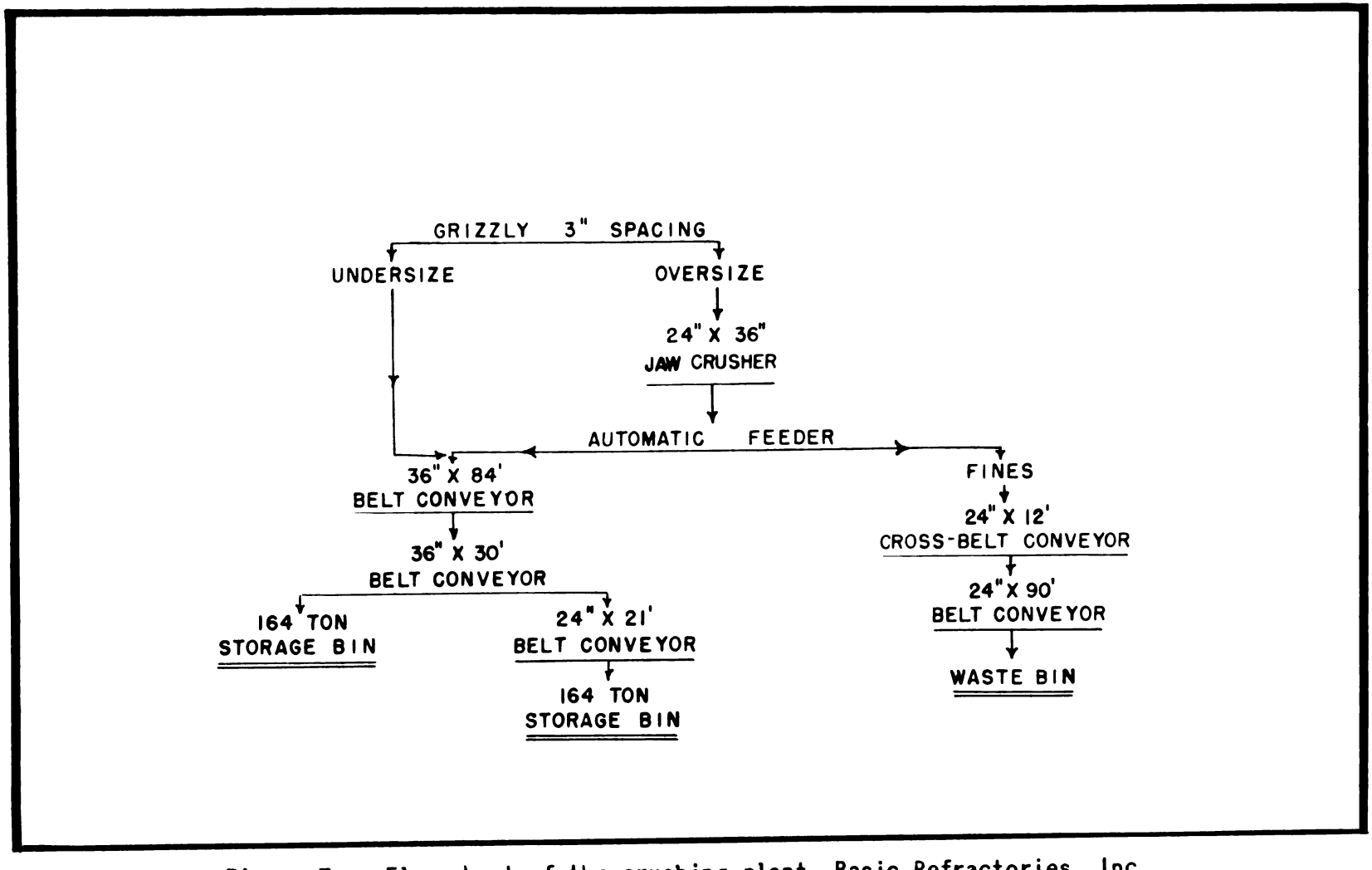

Figure 7. - Flow sheet of the crushing plant, Basic Refractories, Inc.

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1 24-inch by 36-inch jaw crusher
1 Diesel, 125-h.p.
1 Diesel-generator, 60-kw.
1 Electric, 900-kw. welder
1 6- by 8-inch jaw crusher driven by a gasoline engine
1 4- by 6-inch jaw crusher
2 Disk crushers

COSTS

Comparative costs of producing and transporting brucite were furnished by the company (table 1). Pre-war experience has not been included, as production was at a lower level and the method of operation differed from that used in the years shown. The company has pointed out that costs vary considerably, depending on the amount of waste handling involved. For that reason, comparison of this type cannot furnish a true measure of operating efficiency, nor will it reflect an accurate comparison of the effect of changes in prices or labor rates.

TABLE 1. - Basic Refractories, Inc., comparative costs of producing and transporting brucite, 1941-48

	1941, percent	Percent of 1941 rate		
		1942	1943	1944
Tons produced	41,987	39,782	66,692	48,217
Quarrying	100	133	378	433
Crushing and sorting	100	158	240	171
Maintenance	100	125	146	320
Overhead	100	77	168	156
Other:				
Depreciation	100	128	90	123
Trucking-mine to railhead	100	101	127	115
Royalty	100	100	100	100
Total	100	110	212	228

	Percent of 1941 rate			
	1945	1946	1947	11 Months, 1948
Tons produced	56,251	41,717	45,797	37,824
Quarrying	297	348	291	283
Crushing and sorting	122	140	277	365
Maintenance	402	571	388	374
Overhead	99	121	116	151
Other:				
Depreciation	187	292	217	220
Trucking-mine to railhead	115	116	127	128
Royalty	100	100	100	100
Total	178	209	189	196

Note: Quarrying, crushing, and sorting net-ton costs vary considerably as a result of greater or less incidence of waste handled.

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An indication of the relative importance of the various cost components in terms of relation to the total cost, as provided by the company, follows:

	Percent		
	1941	1944	1947
Quarrying	83	89	81
Crushing and sorting	8	4	7
Maintenance	9	7	7
Total	100	100	100

Comparative costs of expendable supplies are:

	1942	1948
Explosives:		
Powder (all classes), per pound	$0.117	$0.137
Fuse, per foot	.007	.009
Caps, No. 6 blasting	.018	.016
Caps, electric blasting	.120	.140
Fuel:		
Diesel oil, per gallon	0.082	0.153
Gasoline, per gallon	.182	.185

	1947	1948
Hot-milling detachable bits, per bit	0.10	0.15

Automotive repair parts increased an estimated 25 percent over 1942 costs.

Wage scales

Labor classification and prevailing and prewar hourly wage rates are:

	1942	1948
Shovel operator	$1.625	$1.75
Shovel oiler	1.10	1.225
Crusher tender	1.10	1.225
Crusher oiler	-	1.125
Comb. heavy duty repairman and welder	1.35	1.625
Tractor operator	1.50	1.625
Apprentice sorter (3 mo.)	-	1.00
Sorter	-	1.125
Sampler	-	1.125
Drillers	1.25	1.375
Jackhammer operators	1.15	1.275
Powderman	1.25	1.375
Powderman helper	-	1.275
High scaler	1.25	1.375
Chuck tender	1.15	1.275
Pit man	1.10	1.225
Water wagon driver	1.07	1.195
Dump trucks, all sizes except 3 axle or larger	1.25	1.375
Flat racks	-	1.225
Trucks, 1/2 ton	-	1.125
Pickup and miscellaneous small trucks	-	1.125
Diamond driller	1.35	1.50
Diamond-drill helper	1.25	1.375
Laborer	.85	-
Laborer, quarry	.90	-

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